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Prof. John C. Warner
with Kind regards of
Lorenzo G. Yates
1893.

# RESEARCHES

AMONG THE

# ROTOZOIC AND CARBONIFEROUS

# ROCKS

OF

# CENTRAL KENTUCKY;

MADE DURING THE SUMMER OF 1846.

BY D. D. OWEN, M. D., AND J. G. NORWOOD, M. D.

ST. LOUIS:
KEEMLE & FIELD, PRINTERS, REVEILLE BUILDING.

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# GEOLOGY
OF
# CENTRAL KENTUCKY.

With a view to clear up some doubtful points in Western Geology, we made, during last summer, an excursion through part of Tennessee and Kentucky, by way of Nashville, Gallatin, Scottsville, Glasgow, New-Haven and Bardstown.

The points to which our attention was mainly directed, were to determine whether the "Cliff" formation of the West—the upper Silurian and part of the Devonian rocks of Europe—existed in Tennessee and the southern part of Kentucky; to observe the succession, bearings, and relative area, occupied by the protozoic and carboniferous or mountain limestone; and to collect, if possible, a greater variety of fossils from the strata above the black slate, which occupy the knobby region of the Western States, in order to obtain additional evidence of the true age of these deposites, which have been usually regarded, on lithological grounds, as having been deposited contemporaneously with the Portage and Chemung groups of New-York and the Devonian rocks of Europe.

An examination of the high ground which runs through the N. W. part of Davidson and Sumner counties, Tennessee, and forms, in the latter county, the water-shed dividing the small tributaries of the Cumberland and Green rivers, has fully proved the existence of rocks, in that region, of the age of the upper Silurian of Europe, situated between the blue limestone (lower Silurian) and the black slate (Devonian?). Though reduced in thickness, and more barren of fossils than farther North, yet they possess very much the lithological character of those beds of our so called "Cliff" formation, lying below the coralline beds; and some are *magnesian* limestone, which may be considered a feature very persistent throughout the extent of this part of the "Cliff" formation, at least in the middle and North-western portions of its range through the Western States.

The following is a section, measured barometrically, of a hill about two miles S. E. of White Creek Springs, six miles N. W. of Nashville, Tennessee.

| | |
|---|---|
| 33 | Black slate. 33-3 ft. |
| 71 | Cliff formation 71 feet. |
| 355 | Blue limestone, 148 ft. down to the Creek; and about 355 feet down to the Cumberland river. |
| 462 | feet, total. |

Near the Slate Lick, between White Creek Springs and Brown's tavern, on Paradise ridge, the black slate measured 51.8 feet. In the schistose layers towards its base, we found abundance of the little *Lingula* represented in the *plate*, fig. 7, (fig. 7*a*, the natural size, 7*b*, magnified 3 times.) It bears some resemblance to *Lingula spatula* of the Genesee slate, though it is rather broader, in proportion to the length, than the magnified figure of that species in Hall's Report.

The turnpike, which has lately been made from Brown's tavern down Paradise Hill, displays a fine section of the rocks above the black slate, which is as follows:—

| | |
|---|---|
| 77 | Soil, siliceous beds, and nodules. 77.7 feet. |
| 29 | Fine siliceous rock with segregations of impure limestone. 29.6 feet. |
| 178 | Impure argillaceous limestone, with calcareous concretions, and beds of water-limestone, passing downwards into bluish grey argillaceous shale. 178.9 feet. |
| 284 | feet, down to the black slate. |

In this section, the line between the black slate and overlying calcareous bed is not well defined, inasmuch as they graduate into one another.

At White Creek Springs, and elsewhere through this region of Tennessee, the beds a few feet above the black slate are crowded with the remains of *Crinoidea*, some of which are of enormous dimensions. This is the "Encrinital limestone" of Dr. Troost, and is the equivalent of the beds above the black slate at Button-mould Knob, in Jefferson county, Ky., seven or eight miles South by East of Louisville.

In the Review of the Geological Reports of New York, published in Silliman's Journal, when speaking of the Western equivalents of what has usually been regarded as the representative of the Portage and Chemung group, (viz: the strata above our black slate, and constituting the knobby region of Indiana, Kentucky, Tennessee, Illinois and Ohio,) the opinion was advanced, that *a part* of these beds were doubtless Car-

boniferous, since casts of *Producti* had been found in them in several places in Indiana, as well as portions of *Archimedes*, by Dr. CLAPP, in Floyd county. The visit of M. ED. DE VERNEUIL to the West, has not only confirmed that view, but he has shown, both from his investigations at Button-mould knob, and by an examination of fossils in the Cabinets of Western Geologists, that the Carboniferous rocks extend, if not down to the black slate, at least to within a short distance of it. He recognises among the fossils found towards the base of our knobs, a number of forms which, in Europe, occur only in *Carboniferous rocks*.—(See *plate*, fig. 4, *Orthis Michellini;* 1, 2, buckler and post-abdomen of *Phillipsia;* 9, *Producta;* 10, 11, 12*a*, 12*b*, *Cyathophylla*.) This being the case, most, if not all, of the groups of rocks which occur in New-York, from the Genessee slate to the top of the Catskill range, are deficient, or obscurely marked in the West; and the Carboniferous rocks rest almost immediately on the schistose beds which represent the Genessee slate; whilst our black slate and the underlying shell-beds of the Falls of the Ohio, with the *Goniatite* limestone of Rockford, Jackson county, Indiana, as well as the upper beds of the glades of Perry county, Tennessee, containing the *Calceola sandalina*, *Atrypa Wilsoni*, *Phacops macropthalma* (Calymena bufo), *Pleurorhynchus*, *Pentremites Rheinwardi*, *Atrypa prisca*, (gigantic variety), *Spirifer* (like *ostiolata* of Schlotheim), *Pileopsis prisca*, &c., are the representatives of the Devonian system of Europe. The *Producta*, fig. 5*a*, 5*b*, and the beautiful *Encrinite*, fig. 13, are from the Carboniferous rocks of Grayson county, Kentucky. The same *Producti* is also found abundantly in the Knobs of Scott county, Indiana. This *Encrinite* is in the Cabinet of Dr. COBB, of Louisville.

In a North-east direction from Nashville, the blue limestone is the surface rock for a much greater distance than towards the North-west. It is not until you approach the confines of Kentucky, that the "Cliff" formation fairly overlaps it, viz: near the base of the ridges which commence some eight or ten miles North-east of Gallatin.

Fifteen miles from Gallatin, and forty, or forty-one miles from Nashville, the road ascends a ridge (Spencer's Hill),

which is a continuation of the Paradise range and the knobs around White Creek Springs. Here, as at Paradise Hill, you reach the black slate soon after you begin the ascent, and then the succession of rocks is similar to that described in the section of Paradise Hill. Near the summit level, where the road traverses, for some miles, the table land of the ridge, near Foster's tavern, we obtained, from a bed of limestone, several specimens of the gigantic variety of *Spirifer striatus* (Sow.),* a species confined to the Carboniferous rocks of Europe. This is another proof that the strata composing this range of knobs belongs to the Carboniferous, and not to the Devonian era.

After a gentle descent of two or three miles, when in the vicinity of Scottsville, the soil assumes the red, ferruginous aspect, indicative of proximity to the limestone and chert beds of the upper division of the mountain limestone, which commences in the "Barrens," a few miles to the North-west. The limestone here, as on the southern side of the ridge, is full of white calcareous concretions. The most abundant fossils noted, are, an *Orthis* (see *plate*, fig. 3), with prominent concentric ribs or markings; and large columns of *Crinoidea*, among which the very peculiar elliptical shaped and twisted entrochites (see *plate*, fig. 6*a*, 6*b*,) are conspicuous. We do not recollect observing these fossils of so large a size or so contorted a form in the upper division of the Carboniferous rocks, but always in the region of the Encrinital beds of the knobs. They occur both at Button-mould Knob, Ky., and Knob Creek, Floyd county, Indiana, beside many other localities within the range of these beds. Elliptical stems of *Encrinites*, of smaller dimensions, however, are found as high as the oölitic and Pentremital beds of this formation, associated, in Monroe county, Indiana, with microscopic polythalamia and univalves. The same fossils (the above mentioned *Orthis* and elliptical *Entrochi*), were the prevalent organic remains for six or eight miles North-east of Scottsville.

Ten miles North-east of Scottsville, we passed a thick bed of chert, similar to that found on Flint creek, a tributary of

* The ribs of this *Spirifer* bifurcate as they proceed from the apex to the circumference, a peculiarity which, M. de Verneuil informs us, is observable in the *Spirifers* of the Carboniferous epoch, and serves to distinguish them from the Silurian and most of the Devonian species.

the upper Wabash, between Attica and Lafayette, Indiana. Two miles further on, in the bed of Barren river, close to the turnpike bridge, the black slate again makes its appearance, overlaid by a brownish and rather schistose limestone, containing concretions; and, some fifteen feet above, in the bank over the road, are Encrinital layers. The total thickness of the calcareous beds above the black slate, at this point of the river, is 62.9 feet.

There has, evidently, been a disturbance in this vicinity, for there is a rapid rise of the rocks up stream. About three quarters of a mile up Barren river, and a few hundred yards from its northern bank, the top of the black slate is twenty-four feet above the level of the dry branch at the bottom of the hill. A quarter of a mile further up, or, about one mile above the bridge over Barren river, the black slate is exposed, from top to bottom, above the water, and measures fifty feet in thickness. Three quarters of a mile below the bridge, a boring has been commenced for salt water on the bank of the river, where the workmen informed us they only reached the black slate at the depth of forty feet from the surface, showing, that the strata must dip here to the North-west at the rate of at least fifty feet to the mile.

The richness of the beds superimposed on the black slate, in the hill one mile above the bridge, is 101.2 feet. The section, one mile above Barren river, is, therefore, as shown in the accompanying diagram. The boring for salt water, on Barren river, is already carried to the depth of 247 feet, and the brine is said to be strong. If it should prove profitable, it is the first instance which has come under our notice of a *productive* brine having been obtained in these rocks.

| | |
|---|---|
| 101 | Soil, and impure limestone containing concretions, with encrinital layers. 101.2 ft. |
| 50 | Black slate. 50 feet. |
| 151 | feet, to an impure greyish limestone at the water level. |

We regret not being able to trace these beds in their easterly curve. If they sweep off in that direction, with a southerly course, to join the Caney Fork, Duck river and Harpeth ridges, as there is strong reason to believe they do, then the area of the blue limestone and "Cliff" formations of Middle Tennessee, is entirely encircled by a zone of Carboniferous

and Devonian rocks, which cross the Cumberland river twice; somewhere near Gainesborough on the North-east, and, on the North-west, between Burton's creek and Sycamore creek, in the South-east corners of Montgomery and Robertson counties, Tennessee, some fifteen miles above Clarksville, forming an irregular ellipse, and enclosing an area occupied by inferior protozoic strata, which may be eighty miles from East to West, and thirty miles from North to South. This zone is, in fact, the amphitheatre of hills which forms the water-shed, down the inward slope of which the small tributaries of the Cumberland river, lying between the above mentioned points, flow from the North and South into that stream.

In the vicinity of Glasgow, the formation of the Barrens commences, viz: the upper calcareous * division of the Carboniferous, or, rather, *sub*-Carboniferous rocks; for, throughout Indiana, Illinois, Kentucky and Tennessee, it is, universally, subordinate to the coal measures, no seams of coal being known to be interstratified with it. Where this formation prevails, the soil is usually remarkably red, being highly charged with oxide of iron. Masses of chert and porous siliceous rocks are strewed over the surface, having resisted longer the decaying influences which have crumbled and carried away the layers of limestone which included them. The timber throughout its range is, for the most part, a stunted growth of oak. The surface of the upland is unusually level, except where it is broken by sink-holes, caused by the undermining action going forward in the cavernous beds of limestone, which is the foundation rock of the country. They form a marked feature in the landscape of Barren county, Kentucky.

This red land is more productive than the growth of timber indicates, owing, no doubt, to the large amount of calcareous matter which must enter into its composition. The loose siliceous masses, above referred to, are charged with *Producti*, *Retepora* (?), and the *Stylina* of Lesueur (Lithostrotion?). *Syringopora* is common in the limestone. This formation continues for nearly twenty-five miles, or until you reach

* We say calcareous division, because, though the inferior division is, locally, more or less calcareous, yet it is oftener siliceous; being either a fine-grained argillaceous sandstone, passing sometimes into a kind of tripoli, or composed chiefly of chert and hornstone, as in some parts of the iron region of Tennessee.

Green river, near its junction with Little Barren river. On the North-east side of Green river, the excavations for the road expose a fine section of the beds of limestone of which this part of the Carboniferous group is composed. The measurement from the bed of Green river up to Dr. COBB's, two miles beyond the bridge, is 194 feet. Nearly the whole of this height is occupied by the limestone in question.

The rock here has a South-west dip, so that the inferior members reach the surface in succession, notwithstanding the gradual rise of the road, and run out towards the backbone of Muldrow's Hill. Its northern slope is composed of the inferior division, passing downwards into schistose argillaceous shale, which graduates into black slate at its base. Though the South side of Muldrow's Hill has so gentle a rise, the North side is exceedingly steep, so much so that the old original road was almost impassable for wagons. Now, the turnpike is constructed with a rise of only 2°. The consequence is, that an immense amount of blasting had to be undertaken, and a fine section of the rock is exposed, which is shown in the accompanying diagram.

| | |
|---|---|
| 27 | Soil and red loam, with nodules of chert. 27.-9 ft. |
| 8 | Limestone. 8 feet. |
| 60 | Shale, with bands of impure limestone. 60 ft. |
| 133 | Thick bed of impure limestone, with concretions, including crystalline and Encrinital limestone, passing downwards into argillaceous shale. 133.3 feet. |
| 71 | Argillaceous shale, 71.5 ft |
| 299 | feet to the Toll-bar. |

The summit level where the turnpike crosses, is supposed to be the lowest passage of the ridge. This is 299 feet above the Toll-bar at the base of the hill. We were taken, by a person said to be better acquainted with the country than any other man in the neighborhood, to what he considered the highest point of the ridge. This proved to be 392 feet above the Toll-bar. From the base of the hill to the back water of the Ohio river, at the junction of the Rolling and Beech Forks of Salt river, is supposed to be 128 feet. If this be correct, the total height of the highest point above the back water of the Ohio, is 520 feet. In the Encrinital beds towards the middle of this section, we found a *Pentremite*, which, though distinct, perhaps, from either the *globosa*, *florialis* or *pyri-*

*formis*, is of a Carboniferous type, and affords, therefore, additional evidence of the period to which these strata must be referred.

The little *Terebratula*, fig. 8, is found very abundantly in the upper beds of Muldrow's Hill. It is peculiarly interesting in consequence of the minute Coralline which has built upon the shell. So far as we can judge from figures, it is precisely the same with one found building upon Terebratulæ and Spirifers of the Carboniferous era, by M. PAILLETTE, in the Asturias, Spain, and which has been figured by MM. DE VERNEUIL and D'ARCHIAC. (The figure given by us was inverted by the lithographer.)

This ridge bears off towards the North-west, running more or less parallel with the Rolling Fork of Salt river, and is the water-shed of its southern tributaries. Near the mouth of Salt river it reaches the Ohio, and is continued into Indiana, where it joins the Knobs of Floyd county, so often referred to in descriptions of the Geology of the West. To the South it must throw off some spurs; for "Grindstone Knob," near Green river, on the North side, and in sight of the turnpike, some miles before it reaches that stream, is, in all probability, of the same date. We are led to this conclusion both from the name, derived from the fact of its affording grindstones, and from the occurrence of black slate, seen in the gravel brought from Green river to make the road in the vicinity of that stream. Eastwardly it continues with a northern curve, and and is supposed to cross the Kentucky river in Estill county, and, probably, joins the Knobs of the Scioto valley South of Portsmouth. We cannot, however, speak with confidence of its bearings in a North-east course, since we have not yet been able to make a personal exploration.

The geological topography of this middle portion of Kentucky, is, in fact, somewhat complicated. It will require a minute geological survey to lay it down accurately in detail; and the more so, if the attempt be made to distinguish, by distinct colors, the inferior and superior divisions of the Carboniferous rocks, which is, perhaps, desirable, on account of the difference in lithological character, and the peculiar features which each stamps on the landscape. In order to show

that they both belong to the same epoch, both might be distinguished by the same positive color, and the division shown by a modification of the depth or shade of that tint. A close examination of the Knobs might result, too, in important discoveries, since it is the same formation which has yielded so much iron ore in Tennessee.

The earliest attempt at a geological chart of the Western States, showed a continuous connection between the range of the Paradise Ridge and the Knobs of Salt river. The inferior division of the Carboniferous group are, however, not exposed to view the whole distance, for the main ridges of these rocks appear to curve off to the South-east and North-east, around the two axes of elevation of the protozoic strata. Nevertheless, there are spurs of the same beds which extend North and South, leaving only about twenty-five or thirty miles of surface in the high ground between Barren and Green rivers, where the beds in question are hidden from view by the upper members of the group.

After passing the Rolling Fork, from two and a half to three miles North, the black slate is seen in place, in the cut made by the turnpike, underlaid by the magnesian beds of the "Cliff" (upper Silurian) formation. Where we had an opportunity of examining them, the fossils seemed to be exceedingly scarce; nor did we recognise, between them and the black slate, the "shell-beds" of the Falls of the Ohio. This representative of the lower Devonian system of Europe, is either absent here or merged in the magnesian beds of our "Cliff" rock.

Five miles further on (eight miles South of Bardstown), in the bed of a stream which crosses the road, the blue limestone (lower Silurian) shows itself beneath the "Cliff" formation. Twenty feet of "Cliff" rock and forty-eight feet of blue limestone are exposed. The latter lies in thin bands of a bluish grey color, with extensive beds of a mud rock, soft marlite interposed. On the opposite side of the creek, the measurement gave seventy-four feet of blue limestone and marlite, up to the *Astrofavosite* bed, and about sixty-five feet of "Cliff" to the top of the hill, which is clothed with cedars, and eleven feet more up to the "Five mile House" (from Bardstown), making, in all, about seventy-six feet of "Cliff" limestone.

On the Beech Fork of Salt river, the "Cliff" (upper Silurian,) measured 117 feet, showing a rapid increase in the thickness of the formation in a northerly direction.

Bardstown stands upon the upper Silurian formation. Seven miles North-west of Bardstown, on the Louisville turnpike, the blue limestone is again seen on descending to the bridge, containing vast numbers of *Delthyris ponderosa* (*Spirifer lynx* *), together with most of its characteristic fossils.

Thirteen miles North-west of Bardstown, the blue limestone measured 170 feet in thickness, up to a banded non-fossiliferous quarry rock, precisely the same as the beds near the base of the "Cliff" formation, in the rail road cut, at Madison, Indiana.

From Mount Washington to Louisville, the "Cliff" formation is the surface rock.

The accompanying section presents, in a connected view, the succession and relation of the formations we have described, as they appear on the surface, from Nashville to beyond Bardstown; i. e. from the axis of the blue limestone in Tennessee, to the same formation in Kentucky.

---

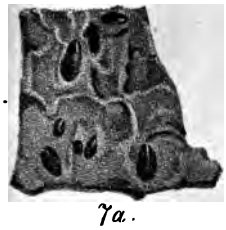
* Though such vast numbers of individuals of this genus have been found in our blue limestone, in all states of preservation, no spiral appendage has ever been observed in their interior. We prefer designating it by the term *Delthyris*, which, though usually considered synonymous with *Spirifer*, does not imply the presence of this structure; and might, therefore, be conveniently adopted for all those allied forms in which the spiral appendage has not been found.

4.

5b.

5a.

1.



7a.

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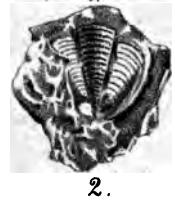

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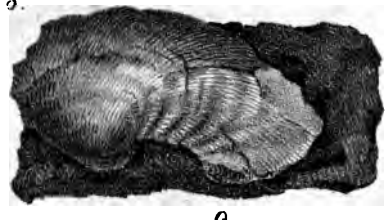

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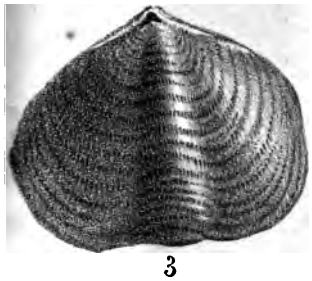

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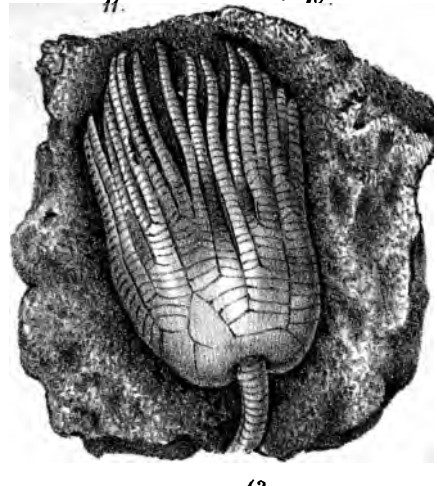

13.

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